Comparison of High-Fidelity Simulation and Lecture to Improve the Management of Fetal Heart Rate Monitoring

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Labor is a potentially hazardous process for the fetus. The dangers of such a process can be prevented by proper monitoring of uterine activity, including assessing fetal heart rate (FHR) and uterine contraction. In obstetric practice, appropriately interpreting the pattern of a cardiotocogram, a technology of electronic fetal monitoring that continuously evaluates FHR and uterine contraction, is an essential skill (Bakker, van Rijswijk, & van Geijten, 2007). This method has become a core competency for obstetric nurses in the care of high-risk pregnancy to assess fetal well-being (Euliano et al., 2016). Inadequate monitoring of FHR is associated with poor birth outcomes (Kc, Wrammert, Clark, Ewald, & Malqvist, 2016). Thus, obstetric nurses need to have specialized knowledge and skills to correctly interpret the signals of FHR and uterine contractions (Miller & Miller, 2012).

Educational training can allow obstetric nurses to obtain sufficient knowledge and skills in the identification of FHR patterns (MacEachin, Lopez, Powell, & Corbett, 2009). Appropriate selection of education strategies is important to make training more appealing (Pettker, 2011). Of the many strategies, the most widely used method is lecture. Lecturing is a straightforward way to impart knowledge; however, the effectiveness of lecture as an instructional method has been questioned.

Background: We developed a training course of fetal monitoring using high-fidelity simulation for obstetric nurses. Method: All participants were assessed by two standardized written tests for knowledge and interpretation of fetal heart rate tracing before and after the training. In addition, a self-estimated questionnaire survey was performed twice—after the training and 6 months later. Results: The knowledge and interpretation of fetal heart rate tracing significantly improved in the simulation group. Compared with the lecture group, the perceived improvements of knowledge and interpretation of fetal heart rate tracing in the simulation group were significantly better following the training and 6 months later. Conclusion: High-fidelity simulation courses are useful in improving the knowledge and interpretation of fetal heart rate tracings for obstetric nurses. They are more effective to improve both short- and long-term management in fetal heart rate monitoring. [J Contin Educ Nurs. 2019;50(12):557-562.]

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Simulation creates a clinical scenario in an artificial setting. Structured simulation-based training has been implemented for more than 2 decades. In particular, high-fidelity simulation recreates a scenario to replace real patient experiences with guided clinical practice that mimics substantial aspects of the real world in a fully interactive approach. It provides nurses with innovative experiences that help to improve care processes in a controlled and safe environment without the potential of harm to patients. Several high-fidelity simulations have been generated for situations in labor and birth (Bastos, Lobo, van Meurs, & Ayres-de-Campos, 2010). There are an increasing number of simulation programs for obstetric teams (Bastos, van Meurs, & Ayres-de-Campos, 2012; Bullough et al., 2016; Ennen & Satin, 2010) and undergraduate nursing students (Overstreet, 2008; Vincent, Sheriff, & Mellott, 2015; Zarifsanaiey, Amini, & Saadat, 2016). Simulation training has been recommended as part of a comprehensive strategy to improve the obstetric outcome (Deering & Rowland, 2013). In a variety of specialties, simulation demonstrates more effective learning than lecture (Daniels et al., 2010; Hsu, Chang, & Hsieh, 2015; Zarifsanaiey et al., 2016).

Literature about simulation for gaining knowledge and skills of fetal monitoring for postgraduate nurses is scarce (Bullough et al., 2016). In this study, a training course of fetal monitoring using high-fidelity simulation for obstetric nurses was designed in the Chang Gung Memorial Hospital. Our study aimed to compare the impact between high-fidelity simulation and a lecture course on the knowledge, interpretation, and competence of FHR monitoring in clinical practice.

**METHOD**

**Study Design**

This research was a quasi-experimental study to compare the effects of simulation-based training and teacher-centered training on the knowledge and skills of FHR tracing among nurses at Chang Gung Memorial Hospitals. The study was conducted from 2017 to 2018. Nurses who worked in the labor and birth units for more than 3 months were eligible for enrollment, whereas those who were not willing to participate in this study were not included. The Institutional Review Board of Chang Gung Memorial Hospital approved the protocol to conduct this study in two hospitals. Informed consent was obtained from the participants before conducting this study.

**Intervention**

The flow chart of the study is presented in Figure 1. Trainees in the labor and birth unit of Linko Chang Gung Memorial Hospital received high-fidelity simulation training courses as the experimental group, whereas trainees in the labor and birth unit of Taipei Chang Gung Memorial Hospital received regular lecture courses as the control group.
group. The training of either simulation or lecture was assigned by a method of purposive sampling. The study period was 6 months for both groups. The outlines of high-fidelity simulation and lecture sessions are shown in Table 1.

High-Fidelity Simulation. Five clinical experts, including local multidisciplinary expertise along with an outside consultant, guided the study (Ennen & Satin, 2010). They produced a set of scenario-based simulations following a series of meetings. Five sessions of high-fidelity simulation were completed in 1 day at the Clinical Skill Center, with a video recording system, a pelvic model, and programmable fetal monitors. The first session began with a quick self-introduction of the standardized team. Each simulation session comprised a brief overview of simulation-based training, a discussion of the use of videotape for debriefing, a detailed orientation to the simulated labor and delivery suite, and review of objectives for multiple assessments of FHR monitoring (Gall, Eden, & Gall, 1985). Each course used a 10- to 30-minute video-recorded scenario. The general debrief included group reflection of clinical implementation by using the videotape of the simulation and a facilitated discussion of participants’ performance with trained faculty. Afterward, a 1-hour high-fidelity simulation was conducted every month for 3 months.

Participants in this group did not receive a structured lecture. All information was conveyed through the scenarios following the debriefing sessions. Faculty instructors were physicians and advanced practice nurses at Chang Gung Memorial Hospital. They had been trained in the field of debriefing and had been actively participating in simulation training courses for the previous 2 years.

Didactic Lecture. Six sessions of traditional teacher-centered lecture training were completed in the classroom (Table 1). The lectures included (a) pathophysiology of maternal and fetal oxygen delivery, (b) uterine contraction and placental function, (c) definition, evaluation, and record of FHR monitoring, (d) management of abnormal FHR, (e) effects of abnormal FHR, (f) and discussion (Gall et al., 1985). Afterward, a 1-hour lecture was conducted every month for 3 months. The contents of lectures were designed according to the recommendations of the American College of Obstetricians and Gynecologists (2009).

Evaluation

All trainees were assessed by two standardized written tests (knowledge and skill) and one questionnaire for clinical management competence. All questions in the written tests were prepared by the instructors and lecturers of the training course. The written tests and questionnaire were the same for both the experimental group and the control group.

Written Test for Knowledge of FHR Monitoring. Before the training course, a written test with 33 questions was distributed to all participants. After the 8-hour training course, a written test containing 40 questions was conducted. The questions between pre- and posttraining tests were not the same. The minimum and maximum scores were 0 and 100, respectively. All questions were prepared by the instructors and lecturers for the training courses.

Written Test for Interpretation of FHR Monitoring. Similarly, a written test composed of 33 figures of FHR records was conducted before the training course—the same tests were conducted again after the 8-hour training course. The minimum and maximum scores were 0 and 100, respectively.

Questionnaire for the Competence of Clinical Management. A questionnaire was designed by three experts with more than 20 years of obstetric experience to assess the competence of clinical management. The perceived self-efficacy was assessed on a Likert 5-point scale (strongly agree, agree, neutral, disagree, and strongly disagree). The questionnaire was delivered to the participants twice—first after the 8-hour training course and then 6 months after the 8-hour training course.

Statistical Analyses

The responses were statistically analyzed using a commercially available program (SPSS® 19.0 for Windows). Categorical variables were analyzed using the chi-square test or Fisher’s exact test. For comparison of quantitative variables between groups, the null hypothesis that there was no difference between groups was tested with a one-way ANOVA. A paired samples t test was used to compare the means of the pre- and postcourse tests. Significance was defined as p < .05.

RESULTS

Demographic Information

In total, 36 nurses in the experimental group and 21 nurses in the control group were enrolled in this study. All participants completed the written tests and questionnaire (response rate = 100%). All participants were female; their demographic information is shown in Table 2. There was no significant difference in age, working period in labor/birth unit, and education level between the experimental and control groups.

Evaluation of Written Tests

The evaluation score of knowledge and interpretation of FHR tracing before and after the training course is shown in Table 3. In the experimental group, the knowledge and interpretation of FHR tracing improved significantly after
the simulation course. In the control group, the knowledge of nurses increased; however, their interpretation ability of FHR tracing did not significantly improve.

**Evaluation of Perceived Competence**

Table 4 compares the perceived competence of clinical management between the experimental and control groups. The results showed that the experimental group obtained higher confidence in knowledge and skills of FHR tracing, with statistically significant difference versus the control group.

Immediately after training, there was a significant difference in the perceived knowledge and skills of FHR tracing between the experimental and control groups. The perceived knowledge and skills were better in the experimental group than the control group; furthermore, participants in the experimental group were more satisfied with the training course than those in the control group.

At 6 months after the training course, sufficient knowledge and skills were more common in the experimental group than the control group; similarly, participants in the experimental group were more satisfied with the training course than those in the control group.

**DISCUSSION**

This study compared the impact of high-fidelity simulation and didactic lecture on the knowledge and interpretation of FHR tracing among obstetric nurses in the labor and birth units. Our study used both quantitative and qualitative analyses to assess the effectiveness of educational training. First, we selected two standardized written tests to determine the knowledge and interpretation of FHR monitoring. Written tests are a traditional method to quantify the objective score of participants for education and training. Second, we used a questionnaire to evaluate the perception of the participants in the competence of FHR monitoring after the training course. Furthermore, our study is unique in its focus on evaluating the FHR of a variety of obstetric situations. The results of our study showed a significant difference in the improvement of knowledge and skills in FHR monitoring between simulation-based and lecture-based courses. The data demonstrated that high-fidelity simulation was better than lecture training in short- and long-term improvements to manage abnormal FHR.

In our research, participants in the simulation group reported better improvement of knowledge and interpretation in FHR monitoring. Similarly, a prospective randomized trial demonstrated that participants in the simulation teams perceived a superior performance in clinical implementation than those in the didactic lecture for obstetric emergencies (Daniels et al., 2010). Practice in a real nonthreatening environment helps to strengthen the learning processes and problem-solving skills (Zarifsanaiey et al., 2016). In this study, participants in the simulation group were given the opportunity to discuss and explore the scenario, which may facilitate the transfer of theoretical knowledge to clinical performance. Our findings suggest that high-fidelity simulation was more beneficial than lecture training for the development of knowledge and skills in managing abnormal FHR.

In this study, obstetric nurses who had participated in either simulation- or lecture-based training courses in the
labor and birth units perceived a substantial improvement in their knowledge and skills of management for abnormal FHR. Perhaps a combination of didactic lecture and simulation may accelerate the knowledge and skills of trainees (Bullough et al., 2016; Phipps et al., 2012). Furthermore, the improvement between study groups was significantly different over time. Our findings showed that simulation with regularly repeated sessions provided a long-lasting improvement in the knowledge and interpretation of FHR tracing than lecture courses. Lecture alone is usually insufficient to permanently change the behaviors of obstetric workers. Adoption of high-fidelity simulation may augment the sustainability of their learning and competence (Ennen & Satin, 2010; Reynolds, Ayres-de-Campos, & Lobo, 2011).

Our study showed that simulation was more helpful in building the confidence of participants in dealing with emergent situations in the abnormal FHR. The finding is in accordance with a previous study showing simulation increased the confidence of decision-making abilities in the management of real-life obstetric emergencies (Reynolds et al., 2011). In addition, simulation training participants were more satisfied with their learning and appreciated their simulation experiences. Learning satisfaction is an important contributing factor toward the development of a clinical learning climate (Papastavrou, Dimitriadou, Tsangari, & Andreou, 2016). These findings suggest that simulation can provide a better learning environment than traditional lecture (Hsu et al., 2015).

**LIMITATIONS**

Limitations exist in this study. Some methodological issues should be cautiously interpreted. First, we did not randomize participants at an individual level; nevertheless, the training course was assigned via randomized selection. Second, we enrolled only participants who have more than 3 months of experience in the labor and birth units. We cannot determine whether simulation is superior to lecture for inexperienced nurses or in different settings (Hussein, Everett, Ramjan, Hu, & Salamonson, 2017). Third, this study was not an audit of actual practice. The results may not reflect the realities of clinical practice under everyday conditions. We cannot be sure that these changes were fully translated into improved clinical care. The variability of findings among published studies might result from the lack of a universal method to measure clinical outcome when comparing the effectiveness of simulation education with other education-based interventions (Hegland, Aarlie, Strømme, & Jamtvedt, 2017).

**CONCLUSION**

To our knowledge, this is the first survey to compare the training program of FHR monitoring between simulation and lecture courses. Our study used both written tests and a questionnaire to determine the knowledge, interpretation, and competence of FHR tracing. The results show that high-fidelity simulation has some advantages over didactic lecture. High-fidelity simulation is useful to provide

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**TABLE 4**

PERCEIVED COMPETENCE OF CLINICAL MANAGEMENT BY LIKERT 5-POINT SCALE

<table>
<thead>
<tr>
<th>Intervention</th>
<th>Immediately After Training</th>
<th></th>
<th>6 Months After Training</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Simulation</td>
<td>Lecture</td>
<td>(p)</td>
<td>Simulation</td>
</tr>
<tr>
<td>My knowledge of FHR monitoring improved.</td>
<td>4.78 ± 0.42</td>
<td>4.00 ± 0.63</td>
<td>&lt;.001</td>
<td>4.94 ± 0.23</td>
</tr>
<tr>
<td>I have sufficient knowledge to identify normal FHR.</td>
<td>4.72 ± 0.45</td>
<td>4.33 ± 0.58</td>
<td>.007</td>
<td>4.81 ± 0.40</td>
</tr>
<tr>
<td>I have sufficient knowledge to identify abnormal FHR.</td>
<td>4.83 ± 0.45</td>
<td>4.57 ± 0.51</td>
<td>.047</td>
<td>4.72 ± 0.45</td>
</tr>
<tr>
<td>My skills to manage abnormal FHR improved.</td>
<td>4.92 ± 0.28</td>
<td>4.14 ± 0.57</td>
<td>&lt;.001</td>
<td>4.92 ± 0.28</td>
</tr>
<tr>
<td>I have sufficient skills to manage abnormal FHR.</td>
<td>4.83 ± 0.38</td>
<td>4.57 ± 0.51</td>
<td>.030</td>
<td>4.97 ± 0.17</td>
</tr>
<tr>
<td>Training course</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I am satisfied with my written tests.</td>
<td>4.78 ± 0.49</td>
<td>3.71 ± 0.64</td>
<td>&lt;.001</td>
<td>4.69 ± 0.47</td>
</tr>
<tr>
<td>I am satisfied with my learning results.</td>
<td>4.83 ± 0.45</td>
<td>4.14 ± 0.57</td>
<td>&lt;.001</td>
<td>4.69 ± 0.47</td>
</tr>
<tr>
<td>I achieved my learning goal.</td>
<td>4.72 ± 0.51</td>
<td>4.19 ± 0.51</td>
<td>&lt;.001</td>
<td>4.69 ± 0.47</td>
</tr>
</tbody>
</table>

Note. FHR = fetal heart rate.
REFERENCES


a risk-free and controllable environment for the obstetric nurse training. In addition, simulation may create more long-lasting improvements than verbal lecture.